Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 1860.1D	**APPROVED BY Signature:**	***Original Signed By***
EFFECTIVE DATE:	January 5, 2017	**NAME:**	Richard D. Barney
EXPIRATION DATE:	January 5, 2022	**TITLE:**	Director, Safety and Mission Assurance

COMPLIANCE IS MANDATORY

Responsible Office: 360/ Safety Division

Title: Ionizing Radiation Protection

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PREFACE

P.1 PURPOSE

This directive describes the Goddard Space Flight Center (GSFC) Radiation Protection Program approved by the Ionizing Radiation Safety Committee for ionizing radiation. It contains the program's organizational and procedural requirements. It further provides radiation protection information to ensure that necessary radiation exposure shall be kept As Low As Reasonably Achievable (ALARA).

Goddard's Radiation Protection Program operates in compliance with two Radioactive Materials Licenses issued by the Nuclear Regulatory Commission, which includes a Type A broad scope license.

P.2 APPLICABILITY

a. These requirements are applicable to all GSFC personnel, facilities, and activities, including all permanent and temporary sites. These requirements also apply to all GSFC tenant organizations, contractors, grantees, clubs and other persons operating under a GSFC license or on GSFC property as required by law and as directed by contractual, grant, and agreement documents. This directive applies only to ionizing radiation. Other types of radiation are covered in other documents.

b. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

c. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission; "should" denotes a good practice and is recommended but not required; "will" denotes expected outcome; and "are/is" denotes descriptive material.

P.3 AUTHORITY

a. U.S. Nuclear Regulatory Commission (NRC) Byproduct Materials Licenses 19-05748-02 and 19-05748-03
b. NPD 1800.2, NASA Occupational Health Program

P.4 APPLICABLE DOCUMENTS AND FORMS

a. NPR 1800.1, NASA Occupational Health Program Procedures
b. NPR 8715.3, NASA General Safety Program Requirements
c. Title 10 Code of Federal Regulations Part 20 (10 CFR 20)
d. Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Licenses of Broad Scope (NUREG-1556, Volume 11)
e. GSFC Form 23-6I, Request for Ionizing Radiation Safety Committee Action – Ionizing Radiation Source Approval

f. GSFC Form 23-6ID, Request for Ionizing Radiation Safety Committee Action - Ionizing Radiation Producing Device Approval
g. GSFC Form 23-26, Radioactive Material Shipping and Receiving Record
h. GSFC Form 23-27, Health Physics Activity Report
i. GSFC Form 23-28I, Ionizing Radiation Source Questionnaire
j. GSFC Form 23-28ID, Ionizing Radiation Producing Device Questionnaire
k. GSFC Form 23-35IP, Ionizing Radiation Source Personnel Approval and Continuation Sheet
l. GSFC Form 23-59, Initiator's Acquisition Checklist
m. GSFC Form 20-4, Transfer/Shipping Request
n. GSFC Form 23-42, Radioactive Material Onsite Transfer

NOTE: All FORMS listed above can be found at: NASA Electronic FORMS website

P.5 CANCELLATION

a. GPR 1860.1C, Ionizing Radiation Protection
b. 360-PG-6400.1.1: Packaging and Shipping of Radioactive Materials

P.6 SAFETY

Safety requirements and numerous safety-related procedures are identified throughout this directive. Specific requirements applicable to procedures resulting from this GPR are described where appropriate.

P.7 TRAINING

Training requirements are specified in Section 2.2.

P.8 RECORDS

Record Title	Record Custodian	Retention/Schedule
GSFC Form 23-6I Request For Ionizing Radiation Safety Committee Action - Ionizing Radiation Source Approval	Radiation Protection Office (RPO) keeps original; users maintain duplicate sets.	*NRRS 8/23.5 CUTOFF ANNUALLY. DESTROY WITH CONCURRENCE OF CENTER OR NASA COUNSEL'S OFFICE 75 YEARS AFTER CUTOFF OR WHEN NO LONGER NEEDED, WHICHEVER IS LATER.
GSFC Form 23-6ID [Device] Request For Ionizing Radiation Safety Committee Action - Ionizing Radiation Device Questionnaire	RPO keeps original; users maintain duplicate sets.	NRRS 8/23.5
GSFC Form 23-26 Radioactive Material Shipping and Receiving Record	RPO keeps original; users maintain duplicate sets.	NRRS 8/23.5

Record Title	Record Custodian	Retention/Schedule
GSFC Form 23-27 Health Physics Activity Report	RPO	NRRS 8/23.5
GSFC Form 23-28I Request For Ionizing Radiation Safety Committee Action - Ionizing Radiation Source Questionnaire	RPO	NRRS 8/23.5
GSFC Form 23-28ID [Device] Request For Ionizing Radiation Safety Committee Action - Ionizing Radiation Device Questionnaire	RPO	NRRS 8/23.5
GSFC Form 23-35IP Request For Ionizing Radiation Safety Committee Action - Ionizing Radiation Source Personnel Approval	RPO keeps original; users maintain duplicate sets.	NRRS 1/130 RECORDS ARE KEPT FOR 2 YEARS. IF EMPLOYEE DOES NOT WISH TO BE RENEWED FOR THE POSITION AT THE END OF 2-YEAR PERIOD, THE RECORD IS REMOVED AND PLACED IN AN INACTIVE FILE. RECORDS ARE RETAINED AT GSFC UNTIL DESTROYED. DESTROY WHEN 75 YEARS OLD.
Radiation Safety Operating Procedures	RPO keeps original; users maintain duplicate sets.	NRRS 8/23.5
Records associated with NRC licenses	RPO	10 CFR 20.2102(b) The licensee shall retain the records required by paragraph (a)(1) of this section until the Commission terminates each pertinent license requiring the record.
Records of personnel experience and training	Supervisors	NRRS 1/130
Records of inspections and evaluations of facilities, equipment, location, and inventory	RPO or designee	NRRS 8/23.5
Records of equipment and facilities, including model numbers, serial numbers, and calibration requirements	User organization, as part of their Radiation Safety Operating procedures	NRRS 8/23/5

Record Title	Record Custodian	Retention/Schedule
Safety Analysis Reports	RPO	NRRS 8/23.5
Reports of violations, contamination, decontamination, etc.	RPO	NRRS 8/23.5
Radiation monitoring records (dosimeters, etc., including levels, names, locations, etc.)	RPO	NRRS 8/23.5
Records of shipments and transfers of radioactive materials	RPO	NRRS 6/7 RETIRE RECORDS TO FRC WHEN 3 YEARS OLD. DESTROY WHEN 13 YEARS OLD.

NRRS 1441.1 – NASA Records Retention Schedules

P.9 MEASUREMENT/VERIFICATION

To assess and provide quality assurance of the GSFC Ionizing Radiation Protection Program, the GSFC Ionizing Radiation Safety Committee during their quarterly meetings shall:

a. Monitor the program to maintain occupational doses as low as reasonably achievable (ALARA).
b. Review and approve (or disapprove) each new (or renewing) user of radioactive material and/or radiation producing devices.
c. Review and approve (or disapprove) each proposed method of use of radioactive material and radiation producing device and ensure it complies with Nuclear Regulatory Commission (NRC) requirements, and other Federal regulations, professional standards, and sound health physics practices.
d. Control possession and use of X-Ray producing machines, particle accelerators, accelerator-produced radioisotopes, or radium and its daughter products/sources of ionizing radiation.
e. Review and approve (or disapprove) procedures and radiation safety program changes prior to submittal to the NRC for licensing action.
f. Review non-compliance reports, including cause, immediate corrective actions taken and action to prevent recurrence.
g. Review occupational radiation exposure records of personnel working with radioactive material and radiation producing devices.
h. Review incidents involving radioactive material with respect to cause and subsequent actions taken.
i. Establish a table of occupational dose levels that, if exceeded, shall initiate investigations and considerations of action by the RSO.

PROCEDURES

1.0 GSFC RADIATION SAFETY PROGRAM

1.1 Introduction

The purpose of the Goddard Space Flight Center (GSFC)'s Radiation Protection Program is to ensure that operations involving ionizing radiation producing sources are conducted in a safe and secure manner

The GSFC emphasizes safety education and training as the primary means of achieving this goal. While the Radiation Protection Office (RPO) provides guidance and performs periodic radiation safety inspections; Custodians, Approved Users, and supervisors are directly responsible for maintaining an atmosphere that promotes full compliance with GSFC's safety policies and procedures.

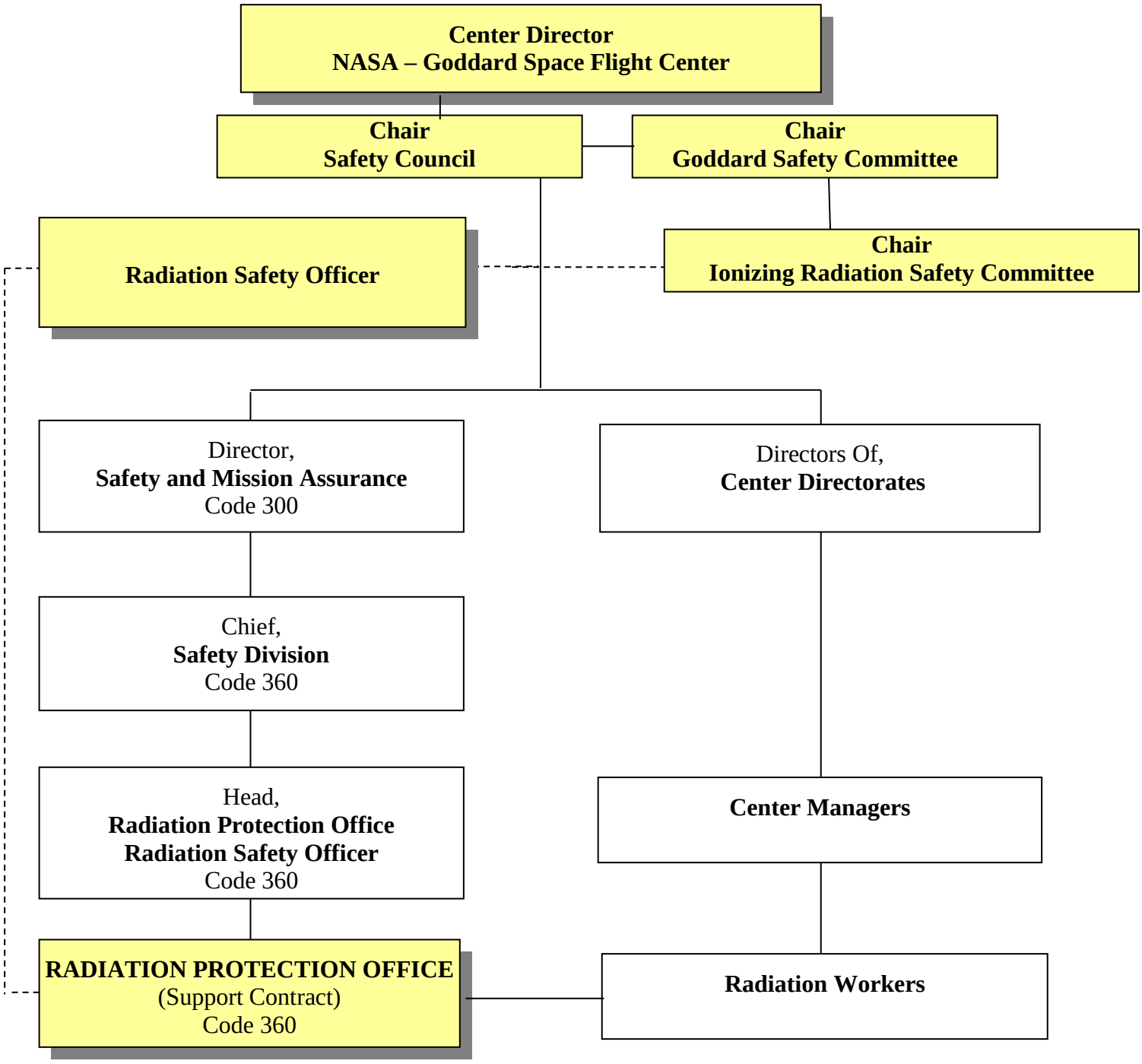
With regard to ionizing radiation safety matters, the GSFC Ionizing Radiation Safety Committee (IRSC) establishes radiation policies and procedures for the GSFC in accordance with requirements set forth by NASA and Federal regulatory agencies. These policies are implemented by the Radiation Safety Officer (RSO), who directs the RPO.

Essential elements of the GSFC radiation safety program are presented in this Goddard Procedural Requirement (GPR). The safety program has been carefully developed to assist all radiation users in utilizing the unique advantages of radiation sources while meeting their safety responsibilities in as efficient and non-intrusive manner as possible. In addition, radiation safety principles and regulatory agency licenses include a goal of maintaining all exposures As Low As Reasonably Achievable" (ALARA). The policies and procedures found in this GPR were designed to promote the achievement of this goal.

GSFC is authorized by the Nuclear Regulatory Commission (NRC) to use radioactive material in operations, research, and development activities on GSFC campus; at temporary job sites of the licensee anywhere in the United States; and on board ships in U.S. coastal waters, at sea, and in inland water where the U.S. NRC maintains jurisdiction. The GSFC NRC license authorizes individuals to use radioactive material. Prospective users shall submit proposals to the IRSC for review and approval. Although this provision allows the Center flexibility in dealing with a multitude of radioactive materials and research uses at various Center locations, it places equally great responsibility on Custodians and administration to handle radioactive materials safely and to comply with NRC regulations and license conditions so that this flexibility may continue.

This GPR summarizes the license conditions, standards, and regulations applicable to the use of various radioactive materials and ionizing radiation devices. Copies of special precautions, regulations, and other operating procedures specified by the IRSC or RSO as a condition for approval to utilize ionizing radiation sources and devices needs to be posted at the approved work area and made available to approved personnel. Everyone involved with the use of ionizing radiation sources and devices shall be familiar with the provisions of this GPR.

1.2 Radiation Safety Organizational Chart



1.3 Radiation Safety Responsibilities

1.3.1 Management

GSFC line management has primary responsibility for the radiation safety of personnel working under their jurisdiction and shall designate Custodians of sources of ionizing radiation and radiation producing devices.

Supervisors shall ensure that radiation sources and/or devices are used only by individuals approved by the IRSC and that all procedures and requirement are met.

1.3.2 Safety Division

Safety Division will be responsible for program oversight and ionizing radiation protection at GSFC facilities and will support all GSFC organizations in matters involving ionizing radiation, including the IRSC. The RPO is a part of the Safety Division who maintains the records associated with the NRC licenses. The Chief, Safety Division will:

a. Ensure a qualified RSO is hired and that there are adequate Contractual personnel available to support the radiation protection program.
b. Sign off on appointment letters for members of the IRSC
c. Review and approve IRSC meeting minutes

1.3.3 Ionizing Radiation Safety Committee (IRSC)

The IRSC is responsible for establishing GSFC's policies governing the procurement, use, storage and disposal of radioactive material and radiation producing devices, which ensures compliance with all NASA, Federal and NRC regulations. The Committee includes individuals experienced in the use of radioactive material and radiation producing devices in research on GSFC's bases. The Committee consists of a Chairman, RSO, representatives of management, and members from divisions on the Center that work with or use radioactive material and/or ionizing radiation producing devices. The duties of the Chair and Committee are listed in the IRSC Charter and the Committee meets at least once each calendar quarter.

1.3.4 Radiation Safety Officer (RSO)

The RSO has administrative responsibility for the Center's radiation safety program. The RPO staff provide a wide range of specific radiation protection services such as personnel monitoring, waste disposal, laboratory surveys, maintenance of records, consultation on the safe use of radioactive materials, and training.

The RSO is responsible for radiation protection on the Center, including general surveillance of overall activities involving radioactive material and all areas where sources are used. He/she is also responsible for compliance with applicable state regulations and NRC license conditions.

All applications for radioactive materials and use of radiation-producing devices, including location, procedures, and possession limit changes, are reviewed by the RSO. The RSO recommends approval or disapproval (to the IRSC) of applications for the use of ionizing radiation sources and devices. The RSO

may approve an increase in possession limit for radionuclides. He/she may suspend any activity that they determine to be a threat to health or property.

The RSO is responsible for investigating overexposures, accidents, spills, losses, thefts, unauthorized receipts, uses, transfers, disposals, and other deviations from approved radiation safety practice, and implementing corrective actions as necessary.

1.3.5 Radiation Protection Program Support Staff

This staff is made up of personnel provided through a service support contract with qualified health physics personnel positioned at the Greenbelt Radiation Protection Office (RPO) and safety personnel positioned and GSFC sites like Wallops Flight Facility and White Sands Complex. These staff members accomplish many requirements associated with the Radiation Protection Program (i.e. radiation surveys, inspections) and support the RSO to ensure that all uses of ionizing radiation sources and devices is done in a safe fashion and meets all federal, state, NASA and local regulations.

1.3.6 Custodians

Custodians are approved by the IRSC and are directly responsible for compliance with all regulations governing radiation safety under their authorization. Custodians are responsible for ensuring that personnel using radioactive materials under his/her authorization are trained in safe laboratory practices, are familiar with the terms of the authorization and are complying with Center policies and applicable regulations. The Custodian will normally be the principal investigator of a research project or the member responsible for a field exercise in which radioactive materials and/or radiation producing devices are used and are responsible for:

a. Ensuring that individuals working under their authorization are using safe work habits to prevent unnecessary exposures to themselves and others.
b. Maintaining an active inventory and knowledge of the various forms and quantities of radioactive material or radiation producing devices that are present in their work areas.
c. Understand the risks associated with the possession, use, and shipment of all radioactive materials.
d. Maintain constant surveillance and immediate control of radioactive material to prevent unauthorized removal or tampering.
e. Ensure that all radioactive material and radiation producing devices in their area are properly labeled.
f. Ensure instruction is given to female radiation workers on the risks associated with working with radioactive materials during pregnancy.
g. Ensure designation of a responsible individual to oversee work conducted under their authorization for short absence and a stand-in custodian with the required committee approvals during extended absences greater than 30 days.
h. Use ionizing radiation sources and devices according to their IRSC approved procedures

1.3.7 Approved Users

Employees that have been approved by the IRSC to be users of radioactive material and/or radiation-producing devices at the GSFC and will be responsible for knowing and observing all applicable

radiological safety regulations. They shall immediately stop operations and report to their supervisor and the RSO all unsafe conditions or operations involving radiation sources or devices. They are also free to raise safety concerns to anyone including the RSO and the NRC.

1.4 Nuclear Regulatory Commission (NRC)

GSFC holds two NRC licenses to use radioactive material for research purposes. GSFC is authorized to possess, use, and transfer byproduct material in accordance with the conditions stated in the licenses.

1.5 Categories of Source Uses/Operations

All ionizing radiation source uses shall be categorized by the RSO, based on their hazard and risk for exposure. The categories are as follows:

LOW: No one could be permanently injured by this amount of radiation. Radiation exposure during normal operations or emergency situations will not exceed radiation dose limits for individual members of the public defined in 10 CFR 20.1301. To ensure that occupational doses and doses to members of the public are as low as reasonably achievable (ALARA), probability will be determined based on the potential for dose above background.

MODERATE: Marginal: It is very unlikely that anyone would be permanently injured by this amount of radiation. However, this amount of unshielded radiation, if not safely managed or securely protected, has the potential to exceed ALARA Notification Levels listed in section 12.2.

HIGH: This amount of radiation, if not safely managed or securely protected, could cause permanent injury to a person who handled it, or were otherwise in contact with it. The amount of radiation produced from this material or equipment has the potential for exceeding occupational dose limits defined in 10 CFR 20.1201.

2.0 IONIZING RADIATION AUTHORIZATION

All Approved Users, Custodians, and uses of ionizing radiation sources or devices, including the radiation sources themselves, require approval by the IRSC. All authorizations are subject to conditions of the NRC licenses held by GSFC and the conditions imposed by the IRSC. Violations of the approved conditions regarding users, uses, or location may result in revocation of the authorization.

2.1 Obtaining Authorization to be an Approved User and/or Custodian of Ionizing Radiation Sources or Devices

The procedure for obtaining authorization is as follows:

a. For most applications to use radioactive material, interim approval may be given by the RSO for up to 30 days until the Ionizing Radiation Safety Committee gives final approval.
b. The proposed individual shall complete a GSFC Form 23-35IP, listing their training and experience working with sources and/or devices, a listing of the sources and/or devices they will be using, and the signature of the Custodian for the sources and/or devices

c. Submit the form to the appropriate project manager/branch head (or higher authority) for concurrence. If satisfied with the request, the branch head (or higher) shall forward the request to the RPO for IRSC approval.
d. The RPO shall review the request to ensure that the individual has the education, training, and experience necessary to handle the ionizing radiation sources or devices requested.
e. The IRSC will approve or disapprove the request and the RPO will notify the individual by providing a copy of the approved or disapproved GSFC Form 23-35IP. Interim approval for a request may be granted by the IRSC Chairman between IRSC meetings and then finalized at the next IRSC meeting.
f. Triennial refresher training is required to maintain User Approval.

Civil service and contract employees are allowed to be either an Approved User or Custodians of ionizing radiation sources or devices at GSFC or GSFC-approved locations. GSFC civil servants, contractors and other personnel operating offsite under GSFC license are subject to all provisions of Goddard's Radiation Protection Program.

2.2 Personnel Training Requirements

Personnel completing a GSFC Form 23-35IP are required to list the radiation safety training they have received. Specific training will be required of each individual based on the hazard of the source(s) they are seeking authorization to use and the manner in which the sources are used. Depending on the use, specialty training may also be required (e.g. Radiation Detector Usage).

2.3 Personnel Experience Requirements

Experience in working with hazardous radiation sources is crucial. A person should have previous experience in handling or operating radiation sources or devices. Experience for this requirement can include that obtained from universities, former employment, and work supervised by a Custodian (who are responsible for keeping records of this experience). This experience will be documented on the individual's GSFC Form 23-35IP. Experience required should be commensurate with the hazard involved and is at the discretion of the Ionizing Radiation Safety Committee. Table 2.3 provides a guideline for assessing the minimum experience necessary to work with radiation sources or devices:

Table 2.3: Experience Requirements

Source Category	Experience Required*
LOW	None
MODERATE	8 hours with these sources
HIGH	40 hours with these sources
*Other requirements may be substituted for experience as determined appropriate by the RSO.	

2.3.1 Supervision of Inexperienced Radiation Workers

Completing radiation safety training does not ensure that inexperienced workers are competent to use all categories (Low, Moderate, High) of radioactive materials or devices without supervision. Inexperienced personnel needing to use radioactive sources or devices will submit a GSFC 23-35IP.

Block #5 will be marked YES for "direct supervision during all operations". The Custodian shall ensure that inexperienced workers are directly supervised during radiation use until such time that the Custodian is comfortable that the worker can handle sources or devices of radiation safely and competently. Once the Custodian is comfortable with this worker's experience a request will be submitted to the RPO to have the original GSFC 23-35IP modified to change Block #5 to NO. This request should include the dates that the worker was supervised.

2.4 Obtaining Authorization to use Ionizing Radiation Sources or Devices

Requests for approval to use ionizing radiation **sources** are initiated by submitting a GSFC Form 23-6I (which describes the who/what/where/why of using the source) and a GSFC Form 23-28I (which is a description of the source) to the RPO. Appendix C addresses the specific requirements for using radioactive sources onboard ships.

Requests for approval to use ionizing radiation emitting **devices** (such as X-Ray machines, accelerators, scanning electron microscopes, etc.) are initiated by submitting a GSFC Form 23-6ID (which describes the who/what/where/why of using the device) and a GSFC Form 23-28ID (which is a description of the device) to the RPO.

Requests shall be submitted by the Approved User or Custodian to the RPO **at least** 2 weeks prior to the need date to guarantee processing. Complicated projects, extremely hazardous operations, offsite activities, and flight activities need to be coordinated with the RSO in early planning stages to ensure that there is no impact to mission schedules.

Approvals are valid for a maximum of **3 years** and may contain conditions that restrict the use of the material for specific purposes at GSFC and approved off-site locations.

The procedure for obtaining authorization is as follows:

a. For new sources or devices; the originator shall prepare the GSFC Form 23-28I or 23-28ID describing the ionizing radiation sources or devices involved and identifying their nominal strengths or settings. For established sources or devices, the originator will list the assigned Docket Number(s) in the appropriate section of the GSFC Form 23-6I or 23-6ID.
b. The originator shall prepare the GSFC Form 23-6I or 23-6ID describing the intended use of the source or device along with safety procedures, showing that the source or device can be properly used, stored, disposed, and transferred with minimum exposure to personnel or damage to property. All operations will be in compliance with GSFC and other applicable regulations. The location and availability of proper equipment (including model numbers, serial numbers, and calibration requirements as applicable) and facilities will be included in the procedures.
c. The originator submits the above forms to the RPO for IRSC approval.
d. When the RPO receives the request, they will perform a health physics evaluation to determine the adequacy of the equipment, facilities, and location of the particular use of the radiation source or device. Operating procedures and source handling techniques will be discussed and evaluated, including final source disposal options. On the basis of the evaluation, the RPO may impose additional conditions to ensure safe operation. Any additional conditions or explanation of non-approval should accompany the request.

e. In some cases, the RPO may require the applicant to submit a safety analysis that indicates probability of a serious incident, its consequences, and mitigation. The RPO shall determine the requirements on a case-by-case basis.
f. The IRSC shall approve or disapprove the request for use of ionizing radiation sources and/or devices, and the RPO will notify the originator by providing a copy of the approved or disapproved GSFC Form 23-6I or 23-6ID. The IRSC may also impose additional requirements.
g. The procedures approved in the request become the conditions under which the Custodian and his/her personnel are approved to use ionizing radiation sources and devices. Any subsequent change in procedure regarding the use, storage or disposal of sources/devices shall be reviewed and approved in writing by the RSO prior to instituting the change.

Contractors operating under a self-license and on contractor-owned facilities shall submit a copy of the applicable license and a full description of their programs to the RSO. The RSO will review submissions and establish any necessary conditions or restrictions as set forth in this GPR.

2.5 Facilities Evaluation

The review of radioactive material use requests shall include an evaluation by the RSO of the adequacy of the proposed facilities. Depending on the quantity of material involved, the type of source and the complexity of the proposed procedures, the following need to be considered:

a. isolation from general laboratories and public areas
b. availability of radiation detection instrumentation
c. adequacy of ventilation and fume hoods
d. appropriate work surfaces and floors (non-porous)
e. provisions for shielding and secure storage of sources

2.6 Inspection and Inventory Requirements

Facility inspections, equipment inspections, and source storage location inspections should be performed annually by the RSO (or designee) to ensure compliance with the approved GSFC Form 23-6I and/or 23-6ID. Source inventory shall be completed (at a minimum) every 6 months by the RPO staff and source inventory, in the same manner, will be required to be verified by the Custodian annually. The possible loss of any source shall be immediately reported to the RSO.

All radiation sources will be subject to inspection and inventory as required by the NRC license. RPO staff will personally view the location of sources during inventory (at a minimum every 6 months).

2.7 Obtaining Approval to Purchase Ionizing Radiation Sources or Devices

The individual requesting the source or device shall be an Approved User and/or Custodian. For sources they will submit GSFC Form 23-28I and for devices a GSFC Form 23-28ID. The requesting individual will follow the requirement in Section 5.

a. The request shall be submitted to the appropriate branch head (or higher authority) for concurrence. If satisfied with the request, the branch head (or higher) forwards the request to the RPO.

b. The RPO will review the NRC license to ensure that no limits are exceeded by this request. The RPO will direct the requesting individual to follow the requirement in Section 5.
c. The initiator shall also submit a GSFC Form 23-59 to the Safety Division on this request.

2.8 Amendments to Authorizations

a. A memo to the RSO shall be submitted for an increase in possession limits, changes in use and storage areas and other minor changes.
b. A Custodian shall submit a new request if other radionuclides are to be used or if procedures change significantly alter radiological hazards under their control.
c. A Custodian who needs to use ionizing radiation sources or devices in a manner other than that already approved shall submit a new GSFC Form 23-6I or 23-6ID, describing the new use to the RSO for IRSC approval.

2.9 Record Keeping

A copy of all forms that have received IRSC approval will be maintained in the Custodian's radiation safety records. The original forms are kept at the RPO. GSFC 23-35IP forms will be maintained by the Custodian and the RPO as long as the individual's employment actively involves use of the ionizing radiation sources or devices. Upon termination or transfer, the form may be archived or removed from the records per GSFC Retention Schedule listed in Section P.8.

2.10 Inactive Status

A Custodian may request in writing to the RSO that his/her authorization to use and store radioactive materials be temporarily changed to an Inactive Status. This status allows for performing and documenting survey/wipe tests and inventories on a less frequent basis. This provision is designed for laboratories that are not planning on using radioactive materials for at least six months. The Custodian may not use radioactive materials with this status (this is a storage only authorization). The Custodian shall submit a request to the RSO to return to active status when so desired. Requirements levied on the work area (i.e. no eating, drinking, smoking, etc.) remain in effect during the inactivity unless the area is cleared by a final clearance survey per 7.8.

2.11 Approval for Onsite Movement of Sources

GSFC Form 23-6I shall be submitted for all actions involving movement of sources on Center (loans, shipments, different users, etc.) from building to building. This requirement does not apply to devices or the movement of a source inside the same building.

Radioactive sources can only be transferred within a building with the authorization of the source Custodian to an Approved User and to a location approved in advance by the RSO. If a source is transferred for more than 90 days, the Custodian shall submit a request for a permanent transfer and obtain approval from the IRSC using GSFC Form 23-6I. Temporary movement of the source will be documented on a "Radioactive Source Sign-Out Log", which will be maintained in the original source storage area.

2.12 Approval for Use of a Source Offsite

Approval from the IRSC shall be obtained to use GSFC licensed material at a temporary job site. This will be in the form of an approved GSFC 23-6I or 23-6ID FORM The user organization is responsible for generating this document, and requires approval by the IRSC at least 6 months prior to offsite material use.

Timely submittal of these documents is recommended because obtaining some approvals can be time-consuming, and additional time may be necessary for correction of procedural discrepancies. Similarly, if international shipments are involved, coordination of International Traffic in Arms requirements with the GSFC Transportation Officer shall occur at least six months in advance.

3.0 RADIATION PROTECTION PRINCIPLES

The body may be irradiated in two general ways: externally from radioactive material or radiation sources, or internally from radioactive material deposited in the body. External doses can be the result of exposure to gamma, X-Ray, or high-energy beta emitters. Low-energy beta and alpha emitters lack the energy needed to penetrate the outer layer of skin and subsequently present less of an external hazard; they are of more concern when internalized. The external dose an individual receives depends on the following factors: exposure, time, distance, and shielding.

3.1 Exposure. The "strength" (activity, mrem/hr, etc.) of the radiation source. By utilizing only the amount of radioactive material needed for an experiment or lowering the current settings on a radiation-producing machine, exposure can be reduced.

3.2 Time. The total dose received from an external source also depends on the amount of time actually exposed to the source. Therefore, any time that is spent near a source shall be minimized and used effectively.

3.3 Distance. By increasing the distance between the source of exposure and an individual, the dose received can be significantly reduced. When an individual doubles his/her distance from a source, the dose will usually be reduced by approximately three-fourths.

3.4 Shielding. When radiation sources are being used, absorbing material or shields can be incorporated to reduce exposure levels. The specific shielding material and thickness is dependent on the amount and type of radiation involved.

3.5 Internal exposure results from the absorption, ingestion or inhalation of radioactive material. This material can be incorporated in the body in several ways: (1) by breathing radioactive gases, vapors or dust; (2) by consuming radioactive material transferred from contaminated hands, tobacco products, food or drink; (3) by entering through a wound; and (4) by absorption through the skin.

3.6 Fundamental objectives of radiation protection measures are: (1) to limit entry of radionuclides into the human body (via ingestion, inhalation, absorption, or through open wounds) to quantities ALARA and always within the established limits; and (2) to limit exposure to external

radiation to levels that are within established dose limits and as far below these limits as is reasonably achievable.

3.7 Radiation Safety Rules

a. Eating, drinking, smoking, chewing gum and the application of cosmetics are prohibited in a room where radioactive materials are used or stored.
b. Protective gloves shall be worn when handling contaminated or potentially contaminated items.
c. Personnel working with unsealed radioactive sources shall wear some type of outer-garment to prevent contamination of personal clothing and exposed skin. The wearing of skirts, opened toed shoes, bare midriffs, etc. are prohibited.
d. Pipetting radioactive solutions by mouth is prohibited.
e. Persons with open wounds will be particularly careful when working with radioactive materials (the wound shall be properly covered).
f. Disposable absorbent pads and remote handling devices shall be utilized whenever possible.
g. Hands will be washed thoroughly after handling radioactive materials, especially before eating. After handling possible sources of contamination, personnel shall contact the RPO to be surveyed for contamination prior to leaving the controlled area.
h. Food items shall not be stored in areas or equipment designated for radioactive materials.
i. Personnel monitoring badges shall be worn in restricted areas as determined by the RSO.
j. Radioactive waste shall be kept in labeled containers.
k. Radioactive shipments shall be handled and stored in specially designated locations.
l. Good housekeeping should be maintained at all times. Contamination/spills shall be cleaned up immediately.
m. Follow the established emergency procedures in the case of an accident.
n. When using volatile radionuclides (e.g. iodine) or heating radioactive solutions, always perform work in a properly operating fume hood.
o. Transport radioactive materials in such a manner as to prevent spillage or breakage and ensure adequate shielding.
p. Label all containers of radioactive materials, to include radionuclide, activity and date of activity. All containers, except those in immediate use, shall be labeled.
q. Utilize shielding when necessary to maintain radiation levels as low as reasonably achievable (ALARA).
r. Store radioactive material in locked cabinets/refrigerators and keep the laboratory door locked when lab personnel are not present.
s. Laboratory glassware used with radioactive materials shall not leave the controlled area.

4.0 RADIATION SAFETY OPERATING PROCEDURES

The user organization shall develop documented safe operating procedures with regard to the use of the ionizing radiation source or device. These procedures will describe the control methods to be used in each application and will be submitted with the GSFC Form 23-6I or 23-6ID when requesting authorization and when renewing every 3 years. Requirements differ, depending on the type of source(s) and the operation, but the following minimum safety operations need to be covered:

Table 4.0: Radiation Safety Operating Procedures Requirements	
Source Type	Procedures Required (Minimum)
LOW	Storage and Security aspects and final disposition
MODERATE	Detailed description of source/device use, storage, security, and final disposition
HIGH	Clear, detailed operating procedures for all phases of the operation including use, handling, storage, security, and final disposition.

In addition to the items described in the Table 4.0, the following requirements shall be addressed. This is not an all-inclusive list, and further items and controls may be necessary depending on the particular use.

a. State that only persons approved by the IRSC may use the sources or device
b. Specify that no eating, drinking, or smoking is permitted in the source use or storage area and that storage of food, drinks, or personal effects is not allowed in these areas
c. Specify necessary personal protective equipment, e.g., gloves, lab coats, safety glasses, respirators, etc., and state that these items shall not leave the radiation area unless verified to be free of contamination.
d. If required, state personnel monitoring requirements, i.e. Whole Body Dosimeter, extremity badge (Wrist, ring), etc.
e. Specify storage and security methods
f. Specify that the source shall be secured from unapproved personnel whenever it is not under the immediate control of an Approved User
g. Specify any special area monitoring, i.e., procedures for checking for area or personnel contamination when required
h. Describe emergency procedures, such as in the case of fire, contamination of source by chemicals, a spill of liquid sources, release of gaseous sources, etc.
i. Specify methods for disposal of radioactive waste (if applicable)
j. Identify specific equipment and facilities, including equipment model numbers, serial numbers, and calibration requirements
k. Specify required warning signs and labels

4.1 Written Procedures

The written Radiation Safety Operating Procedure, documented with the GSFC Form 23-6I or Form 23-6ID, shall be posted at each radiation source or device work area. These procedures will list the Approved Users (along with their Docket Number) for this work area at the end of the procedures. Each Approved User will review and sign these procedures acknowledging that they understand the radiation safety procedures required to use these sources or devices.

Custodians shall ensure that sources and/or devices are used only according to their IRSC approved procedures. These procedures are subject to renewal every 3 years or when the procedures require modification.

4.2 Use of Sources in Launch Operations or Other Offsite Functions

4.2.1 Radioactive Materials Launch List

In coordination with GSFC flight projects, the RPO will compile and submit to NASA Headquarters a list of launches involving radioactive material. GSFC launch and project organizations will furnish the RPO with the launch and source information described in NPR 8715.3 series (Chapter 6), at least 6 months prior to the scheduled launch. The RPO will prepare its report to NASA Headquarters in accordance with established procedures. Coordination shall start with the earliest knowledge or radioactive material involvement.

4.2.2 Approval for Launch Operations

The coordination to launch radioactive material shall occur early enough to ensure timely receipt of range approvals for these materials and conformity with GSFC procedural and licensing requirements. Timely submittal of these documents is recommended because some ranges require as much as 90 days prior notice of intent to use radiation sources.

The RSO will submit an appropriate usage request, in accordance with the usage site's requirements to the appropriate range or site, which will include the following information:

a. Listing and descriptions of all radioactive sources to be delivered to the site, including the associated experiment, whether for ground or in-flight use, and description of activity and date of activity
b. Any available diagram(s) of locations of experiments containing radioactive materials on the spacecraft, sounding rocket, etc.
c. A list of radiological monitoring instrumentation (including calibration dates) and emergency equipment to be made available at the site and the responsible organizations who will provide for these items
d. Descriptions of types of shielding for radioactive materials
e. Applicable licenses for handling the radioactive material
f. Summary of the method of use, storage, monitoring requirement, and precautions to be observed
g. Description of the shipping plan that details the receipt and return of the sources from the use site

4.3 Environmental Testing Certification (Thermal-Vacuum)

The RPO shall ensure the stability of sources that are to be used in adverse conditions. This is to be accomplished by subjecting the source to expected conditions in a controlled situation in a vacuum chamber or other appropriate environment acceptable to the Custodian. The RPO reserves the right to require independent certification of sources.

Source design criteria (other than NRC-approved sealed sources) shall be reviewed and approved by the RSO prior to use.

All sources to be launched, and any source(s) used in thermal vacuum chambers at GSFC during integration of payload(s), shall be thermal-vacuum qualified.

5.0 ACQUISITION OF RADIATION SOURCES OR DEVICES

5.1 Purchasing Radioactive Materials or Ionizing Radiation Devices

When ordering radioactive materials, the appropriate GSFC Form 23-28I or GSFC Form 23-28ID will be sent directly to the RSO. A GSFC Form 23-59 shall be submitted to the Safety Division to get approval for this acquisition. Initiators of purchase request will ensure that these approvals are obtained before processing of the purchase.

A unique GSFC source serial number will be obtained from the RSO and shall be designated on the purchase request to be placed on the source during manufacture. This number is required on other approval forms for radioactive material purchases. Such approvals can be obtained simultaneously with other approvals, such as approval for use or approval of sources or devices.

5.2 Radiation Protection Office (RPO) Review

The RPO shall review the order request to determine the following:

a. The user has been approved to use the type and quantity of radioactive material being ordered. The name of the Custodian shall be clearly indicated on the order.
b. The radioactive material being ordered will not cause the Custodian's inventory limits to be exceeded
c. The Custodian has no unresolved items of safety noncompliance, including responses to survey reports and training notices
d. The Custodian's radionuclide inventory reports are current

When the above criteria are met, the order will be approved and the requestor will be notified to place the order. If the above criteria are not met, the Custodian will be immediately notified to expedite provision of the necessary information.

5.3 Receipt and Delivery of Radioactive Orders

The RPO is open for receipt of radioactive material shipments 8:00 a.m. - 4:30 p.m., Monday - Friday, Center holidays excepted. Delivery shall be made to RPO staff directly; shipment may not be left unattended in any area. Upon receipt of a shipment, the package is surveyed in accordance with Department of Transportation (DOT) and NRC regulations, added to the Custodian's inventory record, and delivered to the Custodian’s lab.

6.0 RADIOACTIVE MATERIAL INVENTORY

The RPO is required to maintain accurate, timely records of the receipt, use, transfer and disposal of radioactive material in its possession. Custodians have this same responsibility for their sources. The most recent record shall be maintained by the Custodian and be readily available for periodic review by the RPO and/or regulatory personnel.

A source ID number is assigned to each radioactive source logged in through the RPO. This number is physically attached to each radioactive source. The source ID number provides a unique means for identifying each source. The abbreviations (normally two letters) for the radioisotope is used as the first part of the number, followed by a dash, then the mass number for the radioisotope, followed by a dash,

then the three digits ascend sequentially numbered for this specific type of radioisotope. For example, Co-60-252 would be the source ID number for the 252nd Cobalt-60 source used on the Center.

6.1 Inventory of Devices

The RPO has an inventory of the devices emitting radiation or containing sealed sources or foils, such as liquid scintillation counters and gas chromatographs. Each instrument will be posted with an identification sticker designating the radiation source information. The RPO will be notified if the location or status of this type of device changes. Arrangements shall be made to have the radiation source in the device removed prior to transferring it to Excess Property. The Custodian will notify the RPO prior to any changes in the location of these devices.

6.2 Inspection and Inventory Requirements

Facility inspections, equipment inspections, and source storage location inspections will be performed by the RPO to ensure compliance with the approved GSFC Form 23-6I and/or 23-6ID. Radioactive Source inventory shall be completed (at a minimum) every 6 months by the RPO staff and source inventory will be required to be verified by the Custodian annually.

6.3 Sealed Source Leak Tests and Inventories

The RPO performs all sealed source leak tests. All beta/gamma and neutron sealed sources (greater than 100 microcuries) will be tested for leakage and inventoried at intervals not to exceed six months. All sealed sources (greater than 10 microcuries) designed for the purpose of emitting alpha particles will be tested at intervals not to exceed three months. Sealed sources need not be tested if they contain only hydrogen-3, they contain only a radioactive gas, or the half-life of the isotope is 30 days or less.

7.0 RADIATION CONTROL PROCEDURES

GSFC conducts a comprehensive control program to ensure that radiation sources or devices are safely used, thereby preventing unnecessary exposure to personnel. Prevention of the spread of contamination and minimizing radiation exposure is the ultimate responsibility of the Custodian, but all Approved Users are responsible for following these procedures. The Custodian is also responsible for providing appropriate laboratory safety equipment and supplies (shielding, gloves, fume hood, etc.). These controls are designed to ensure compliance with GSFC guidelines and NRC regulations.

7.1 Radioactive Source Use – Sign out Log

All radioactive sources taken out of their storage area shall be documented on the "Radioactive Source Sign-Out Log", which will be maintained in the original source storage area. When the source is removed, all sections of the log (except the "date returned" and "checked in by (initials)" blocks) will be completed. This applies to using the source in the same room where the storage area is located. When the source is placed back into the storage area, the "date returned" and "checked in by (initials)" will be filled in to complete the line entry. The RPO will verify that this log is being utilized and is being completed as required.

Any source that has not been used at least once in 24 months will be moved to the RPO radiation storage area.

7.2 Facility Radiation Safety Equipment

The IRSC shall require that special radiation safety equipment be installed when deemed necessary for personnel protection. Detectors, interlocks, glove boxes, fume hoods (with appropriate filters); remote control equipment, manipulators, tongs, etc. may be required for safe operations.

7.3 Calibration of Survey Instruments

Instruments shall be calibrated at least annually. Calibrations may be performed by the RPO without charge. The RPO will be informed of the purchase of a new instrument or repair and factory calibration of an existing instrument.

7.4 Radiation Levels

External radiation levels shall be kept ALARA.

7.5 Radiation Protection Office (RPO) Surveys

Surveys will include measurements of external radiation levels near sources in use, storage, waste containers, etc. and of removable contamination by wipe testing. Both restricted areas (areas posted with radiation warning signs and labels) and adjacent unrestricted areas will be surveyed as applicable. Surveys should also include an examination of the presence and condition of warning signs, instructions and other necessary postings and a thorough review of the record keeping system. Survey results will be documented on GSFC Form 23-27, maintained in the RPO and results reported back to the Custodian.

RPO staff will periodically (typically every 6 months) inspect the laboratories of Custodians to monitor the lab's radiation safety program. Radiation exposure rates and removable contamination levels will be measured and record-keeping systems reviewed during the surveys. The RPO will also ensure that appropriate storage containers, equipment, and security measures are provided for proper handling and to prevent unapproved personnel from using radiation sources. Each radiation safety inspection is recorded. A report of each inspection's significant findings is routed to the Custodian, with a timetable for correction. If satisfactory correction is not achieved in a timely manner, the Custodian's radioactive material ordering privileges are terminated. Any situations that the RSO cannot resolve are remanded to the IRSC, as necessary.

The frequency of surveys will be determined by the quantity of radioactive material used, results of previous surveys, and general compliance with Federal and GSFC policies. Although the RPO inspections fulfill a need for supervisory overview, they **do not** provide adequate day-to-day information regarding the effectiveness of radiation control procedures used in the laboratory. Therefore, Custodians shall routinely monitor their laboratories when using radioactive material.

7.5.1 Meter and Contamination Surveys

Areas where radioactive materials are used or stored shall be checked every 6 months by the RPO to ensure that radiation levels and contamination does not exceed GSFC limits. Appropriate air samples will be taken during any operation where contamination could become airborne and inhaled. Decontamination operations shall be performed only by the RPO staff or under their direct supervision.

The following items shall be a part of the survey record:

a. Diagram of area surveyed
b. List of items and equipment surveyed
c. Specific locations where wipe tests were taken
d. Ambient radiation levels with appropriate units (mrem/hr)
e. Contamination levels found with appropriate results (dpm/100 cm^2)
f. Make and model number of survey instrument used
g. Background levels (mrem/hr)
h. Name of the person making the survey and recording the results, and date

7.5.2 Testing for Contamination

Tests are performed by wiping the areas of interest with a filter paper disk and then determining the activity in a counter calibrated for the suspected radionuclide. Wipe tests are more sensitive than instrument surveys and should be used when instrument surveys indicate possible contamination. They are the only practicable method of monitoring for weakly penetrating beta emitters, such as ^{3}H, ^{14}C and ^{35}S. They should be used for all surveys conducted for the purpose of identifying and/or documenting removable contamination levels.

Sealed radiation sources shall be subject to leak tests by RPO staff as determined necessary by good health physics practice, Sealed Source Registration Certificates, and in accordance with NUREG-1556, Vol. 11, Appendix T. Leak test will also be conducted whenever sources are transferred, shipped or received. If a source is being transferred onsite and has been leak tested within the past 90 days, the transfer leak test may be waived by the RSO.

7.5.3 Leakage/Contamination Levels for Sealed Sources

Table 7.5.3 lists the sealed source leak test (leakage/contamination) limits.

Table 7.5.3: Leakage/Contamination Levels for Sealed Sources

SEALED SOURCE LEAKAGE LIMITS				
Restriction of Use	**Maximum Amount of Leakage or Removable Contamination**			
	Alpha		**Beta/Gamma**	
	microcuries	**Becquerels**	**microcuries**	**Becquerels**
None	<1E-05	<0.37	<1E-04	<3.7
*Conditional use (i.e., use of enclosure and strict contamination controls)	≥1E-05 <5E-03	≥0.37 <185	≥1E-04 <5E-03	≥3.7 <185
Disposal as radioactive waste or return to manufacturer	≥5E-03	≥185	≥5E-03	≥185

*Handled and used as “unsealed source” until experiment is concluded with ultimate disposal as radioactive waste.

7.6 Removal or Transfer of Laboratory Equipment

Any equipment in the laboratory which could have been contaminated with radioactive material shall be surveyed before removal to another laboratory, transfer to a repair shop, or transfer to Excess Property. Before the equipment is transferred and following a satisfactory survey, all warning signs and stickers will be removed. The Custodian transfers the cleared item to Excess Property. The acceptable surface contamination levels for uncontrolled release of equipment, and ALARA, is established by the Table 7.7.

7.7 Acceptable Surface Contamination Levels for Uncontrolled Release of Equipment

The values in Table 7.7 apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, apply the limits established for alpha- and beta-gamma-emitting nuclides independently.

Table 7.7: Acceptable Surface Contamination Levels for Uncontrolled Release of Equipment

Nuclide	Removable[a,b]	Total (Fixed + Removable)[a,c]
^{nat}U, ^{235}U, ^{238}U and associated decay products	1,000	5,000
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	20	500
^{nat}Th, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[d]	1,000	5,000
Tritium and tritiated compounds[e]	10,000	NA

[a] As used in this table, dpm (disintegrations per minute) means the rate of emissions by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] The amount of removable radioactive material per 100 cm^2 of surface area shall be determined by wiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the wipe with an appropriate, calibrated instrument of known efficiency. (Note: The use of dry wipe material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area will be based on the actual area and the entire surface will be wiped. Except for transuranics and ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa and alpha emitters, it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the acceptable limits for removable contamination.

[c] The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified.

[d] This category of radionuclides includes mixed fission products, including the ^{90}Sr which is present in them. It does not apply to ^{90}Sr which has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

[e] Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface radioactivity value provided in this table is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore a "Total" value does not apply

7.8 Vacating Laboratory Spaces

The RPO shall be informed of all changes in approved laboratory spaces, including transfers or departures from the Center and laboratory relocations. The Custodian is responsible for surveying all spaces and equipment and proper removal of all radioactive waste and radioactive sources prior to the changes. Upon notification, the RPO will complete a final clearance survey of the approved spaces. Only the RPO may remove radiation warning signs.

7.9 New Laboratory Setup

A New laboratories' setup shall be inspected and approved for use by the RPO. The Custodian will contact the RPO to schedule the set-up. The Custodian will provide waste containers, which are approved by the RPO. The RPO staff will review procedures and answer any other questions regarding radiation safety matters.

7.10 Posting and Labeling

The RPO is responsible for the posting of all radiation warning signs. Labeling equipment and lab supplies is the responsibility of the Custodian. The "Notice To Employees" NRC Form 3 will be posted by RPO staff, but Operating and Emergency Procedures will be posted by the Custodian prior to the first use of these procedures in that area. A copy of this directive should be readily available.

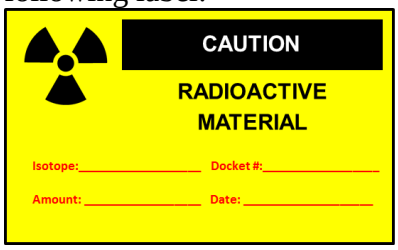
All doors accessing areas that contain radioactive materials shall be posted.

All refrigerators, freezers and other equipment which contains radioactive materials shall be labeled with "Caution: Radioactive Material" signs or tape prior to placement of the material.

Any unattended container of radioactive material, such as beakers or flasks, shall be labeled. A rack of radioactive test tubes need to be labeled, but not necessarily each test tube. Common sense should prevail. Labeling prevents someone from unknowingly disturbing the materials or getting unnecessary exposure from them.

7.10.1 Labels for Radiation Sources and/or their Containers

All sources of ionizing radiation and/or their containers shall be clearly labeled with the standard radiation symbol and appropriate information. The RPO will provide the tags, and only RPO staff may remove the tags. The total activity of sources in containers will be listed, by radionuclide, on the following label:



7.10.2 Signs for Radiation Control Areas

Standard magenta and yellow signs bearing the radiation symbol and an appropriate legend shall be placed by the RPO in the following potential hazard areas. Waivers in particular cases may be granted by RSO.

Radioactive Materials Area - The following sign shall be posted by the RPO in each area or room where used or stored radioactive material is ten times greater (or its equivalent) than the amount exempted in Appendix C of 10 CFR 20:

Radiation Area – The following sign shall be posted by the RPO in areas where radiation levels are high enough to result in an individual receiving a dose equivalent in excess of 5 millirem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates:

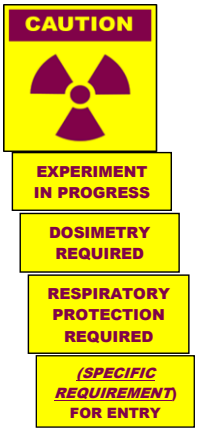
High Radiation Area - The following sign shall be posted by the RPO in each accessible area, where radiation levels could result in an individual receiving a dose equivalent in excess of 100 millirem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates:

Airborne Radioactivity Area - The following sign shall be posted by the RPO in any area in which airborne radioactivity exceeds the limits specified in 10 CFR Part 20, Appendix B, Table 1:

Contaminated Area - The following sign shall be posted by the RPO in any area in which removable contamination exceeds the limits of a general use area:

Laboratory Equipment – When radioactive material is used inside equipment for research purposes, the equipment shall be appropriately labeled to indicate the presence of a source:

Additional Inserts - Other inserts are available from the RPO and can be used in combination with the basic signs previously described. Some examples are presented below:



7.11 Eating, Drinking, Smoking and Application of Cosmetics in the Laboratory

Eating, drinking, smoking and application of cosmetic in any laboratory where radioactive materials are used or stored is prohibited. This is in recognition of the potential inhalation and ingestion hazards and is consistent with good health physics practices.

7.12 Fume Hoods

To protect personnel from exposure to airborne radioactive material generated by laboratory procedures, a properly ventilated fume hood shall be used. Few radioactive material procedures require the use of a hood, although hood use is recommended. This is more due to the well-confined workstation than ventilation protection. Annual hood inspections are believed to be adequate, when certified by the Industrial Hygiene Office. There are three procedures that specifically require the use of a fume hood:

a. iodinations
b. evaporations
c. use of gaseous radioactive material

The most effective way to use the hood is to place your apparatus at least six inches inside the hood with the sash no higher than that needed to allow unobstructed use of your hands. Also, the sash bottom shall be no higher than the mark that indicates an airflow of 80 to 150 linear feet per minute (A simple method for monitoring the airflow of a hood is to tape a strip of tissue paper to the bottom of the sash). If you have questions or doubts concerning the proper functioning of the hood you intend to use for volatile radioactive experiments, call the RPO. Do not use a hood that is not working properly when handling such material. All fume hoods are inspected and face velocity measured annually by the Industrial Hygiene Office. Any hoods needing service are reported to Code 220, Facilities Management Division. Each hood is posted with a notice which specifies the measured face velocity, date and person performing the inspection.

7.13 Personal Protective Measures

The use of personal protective equipment (PPE), such as laboratory coats, disposable gloves and respirators, can minimize contamination of personnel and thus keep radiation exposures low. When risk

of contamination exists, RPO shall require the use of PPE. PPE may include, but not be limited to, garments, safety glasses, and respirators. The use of PPE will be verified during RPO inspections.

7.13.1 Protective Clothing

Protective clothing, such as a laboratory coat, shall be worn by the user when there is a potential for accidental skin exposure and possible absorption of the radionuclide.

7.13.2 Disposable Gloves

Wear disposable gloves whenever working with radioactive material or else contaminated hands may result. Once a glove is contaminated, it shall never come into contact with anything that is to be kept contamination free. Removal of the gloves before touching anything should always be the rule. Gloves should be removed from the inside out to prevent contaminating your hands during removal.

7.13.3 Respiratory Protection

The use of respirators is generally not necessary. A properly operating fume hood provides adequate protection for most procedures (such as iodinations and evaporations). Powdery radioactive materials will be handled in a glove box, negating any need for a respirator. Only operations involving potential room releases of radioactive materials, such as the changing of hood air filters, would require a respirator. No respirator-requiring activities shall be conducted without approval of the RSO and the Industrial Hygiene Officer. Users will be fit-tested and have an approved Respirator Protection Plan.

7.14 Transporting Radioactive Materials (On Campus)

All transfers of sources shall be coordinated with and approved by the RPO. See Section **11.1: On Campus Transfers** about the movement of sources between buildings. When transporting radionuclides between rooms (only done by IRSC Approved Users) or buildings (only done by the RPO), precautions should be taken to minimize the risk of accidents and the risk of exposing the public to radiation. Liquid or Gaseous sources are required to be transported in a secondary containers to avoid breakage of the primary container and there should be enough absorbent material surrounding the source to retain the isotope in case of breakage. Shielding will be used to ensure radiation levels are adequately controlled.

7.15 Security of Radioactive Materials

Radioactive material needs to be secured from the possibility of unauthorized removal during times when approved laboratory personnel are not present. Radioactive material not in use shall be stored in a locked cabinet/safe or other devices approved by the RSO. When in use and not attended by an approved user, the area must be secured (locked) or the source must be internal to a secured device or chamber so as to be inaccessible to unauthorized personnel, including janitorial personnel.

8.0 RADIOACTIVE WASTE GUIDELINES

The Center has adopted a goal of waste minimization and shall implement strategies to reduce the amount of radioactive waste that needs to be disposed of, using techniques such as waste segregation, compaction, and holding for decay. Universal cooperation is needed in order to ensure safety, comply with regulations, reduce costs and minimize environmental hazards

Disposal of radioactive material and contaminated items shall be arranged by the RPO. When a source is no longer needed or begins to indicate leakage, the Custodian will contact the RPO to arrange for disposal. Independent disposal or transfer of radioactive materials is prohibited. Disposal restrictions apply to all radioactive materials including generally licensed items, regulatory-exempt items, and naturally occurring and accelerator-produced materials.

Specific rules governing waste disposal are changing constantly; therefore contact the RPO for the latest guidelines.

9.0 PERSONNEL EXPOSURE MONITORING

9.1 External Exposure

Personnel monitoring devices (Thermoluminescent Dosimeters, pocket dosimeters, etc.) are provided by the RPO to measure an individual's radiation exposure from gamma, neutron, energetic beta and X-ray sources. The standard monitoring device is a clip-on badge or ring badge bearing the individual assignee's name and a unique identification number. The badges are provided, processed and reported through a commercial service company that meets current requirements of the National Institute of Standards and Technology National Voluntary Laboratory Accreditation Program.

9.1.1 Limits for External Radiation Exposure for Radiation Workers

Combined exposure from licensed and non-licensed sources shall not exceed NRC limits stated in Title 10 Code of Federal Regulations (CFR), part 20. Exposure to external radiation will not exceed the limits as noted in Table 9.1.1:

Table 9.1.1: Limits for External Radiation Exposure for Radiation Workers

Parameter	Dose Limit per Calendar Year	
	Rems	Sieverts
Total Effective Dose Equivalent	5.0	0.05
Sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue	50	0.5
Shallow dose equivalent to the skin of the whole body or to the skin of any extremity	50	0.5
Lens Dose Equivalent	15	0.15

9.1.2 Limits for External Radiation Exposure to Members of the Public

Radiation levels in unrestricted areas in which members of the public may be exposed to shall not exceed 2 mrem/hr (20 microsieverts/hr) and 100 mrem (1 mSv) in a year.

9.2 Monitoring Requirements

Radiation protection regulations and Center policy require that appropriate personnel monitoring equipment be provided to individuals who:

a. are likely to receive an annual radiation dose in excess of 10 percent of Table 9.1.1 annual dose limits or an intake of the applicable ALI listed in 10 CFR 20, Appendix B.

b. are less than 18 years of age and are likely to receive a radiation dose in any calendar quarter in excess of 1 percent of the doses listed in Table 9.1.1.
c. are radiation workers and have declared a pregnancy or planned pregnancy.
d. enter a High Radiation Area (exposure to greater than 100 millirems in any one hour).

Operations may be monitored for a specified period of time to determine if there is a need for continuation of personnel monitoring.

9.2.1 Procedures for Monitoring Devices (Badges)

Custodians will instruct potential Radiation Workers to file a GSFC Form 23-35IP to show what radiation sources they will be working with. This form provides for the basic information regarding training and experience. Initial personnel monitoring decisions will be based on this information. Further evaluations, and re-evaluations, will be made through radiation employee renewals, application reviews, personnel monitoring reports, ALARA investigations, surveys and individual interviews by RPO staff members.

Badges are exchanged on a quarterly basis. Badges shall be made available to the RPO staff by the close of an issue period so that they may be properly processed. The RPO will send out notices to personnel alerting them when the issue period will end and that those badges are to be returned to the RPO.

Ring badges are assigned to workers who use one (1) millicurie or more of higher energy beta (^{32}P, ^{90}Sr, etc.) or gamma emitters at any one time. Individuals who work solely with low-energy beta emitters (such as ^{3}H, ^{14}C, ^{35}S or ^{45}Ca) do not need badges or when quantities used at any one time are less than one (1) millicurie. The RSO may require the use of pocket dosimeters, ring badges, or other monitoring devices when particular procedures are in operation.

9.2.2 Personnel Monitoring Protocol

The RPO will request prior radiation dose histories from all new Approved Users. The RPO shall maintain all personnel occupational radiation dose records.

The RPO will maintain a system for tracking the badges and ensuring that dosimeters are exchanged on a routine basis. The RPO will notify the Custodian and the badged individual if any significant dose is found when personnel are monitored.

It should be the responsibility of each individual badged recipient to wear and use the badge(s) properly. Custodians are responsible for assuring their radiation workers are wearing badges appropriately and that badges are returned on time for processing. Custodians/Approved Users may lose their IRSC approval for consistent late or lost badges. Custodians shall ensure that employees are removed from the dosimetry program when they leave NASA service or are transferred out of the area.
Custodians shall ensure any individual suspected of having received an overexposure does not resume radiation work until either the RSO or the IRSC has evaluated the suspected exposure. Overexposure is defined as a whole body radiation dose greater than 4 millisieverts (400 mrem) per 30 days.

9.2.3 Use of Personnel Monitoring Devices

The whole body badge (or other device) is to be worn on the body where it will most likely approximate the radiation exposure to the head and torso of the wearer. A badge assigned for whole body monitoring is not to be used to monitor the extremities (hands, forearms, feet, ankles). Separate badges will be assigned for extremity monitoring. Badges shall be worn only by the person they are assigned to and only at approved Center facilities or temporary job sites. The exposure of a personnel monitoring device to deceptively indicate a dose delivered to an individual is prohibited by federal regulations.

Generally, whole body badges are to be worn between the waist and shoulders. Personnel leaving radiation control areas shall leave their assigned badges on a rack designated by the RPO. When a protective apron is worn, the badge is to be worn at the collar, outside the apron. The RSO should be consulted for advice in these circumstances.

Extremity monitoring badges (rings) are available for the right or left hand. Ring badges will be worn whenever working with applicable sources. When using radioactive materials, the ring monitoring element (label area) shall be turned toward the palm. Gloves should be worn over the ring badge when contamination is possible.

Any individual not routinely monitored shall be issued a temporary dosimeter before they enter a "Radiation Area". Custodians will contact the RPO to arrange for a temporary dosimeter issue.

9.3 Personnel Monitoring Reports

Routine monitoring periods are quarterly. Each report includes the name, monitoring period date, dose (in rem) for the monitoring period, current calendar quarter and calendar year.

The personnel monitoring reports are on file in the RPO. They are available for all badged employees to review. Annual reports (NRC Form 5 equivalents) will be provided to each individual badged in the previous year, except for personnel that have transferred. Badged personnel shall be notified when quarterly results are available for their review in the RPO. Due to Privacy Act issues, no report will be sent by the Center wide mail system. The reports are considered medical records; therefore, individual's exposures are not released except with written consent from that individual.

9.4 GSFC Pregnant Employee - Fetal Dose

GSFC incorporates safety information and radiation dose guidelines for ensuring safe radiation limits for the embryo/fetus of occupationally exposed employees.

Radiation workers are strongly advised to notify the RPO as soon as possible after a pregnancy is confirmed. The declaration of pregnancy is voluntary, but it shall be made in writing. The Center is then obliged to take steps to ensure that the occupational radiation dose received by the embryo/fetus does not exceed the limit specified by Federal regulations of 500 millirem for the entire gestation period. In addition the National Council on Radiation Protection and Measurements (NCRP) recommends that the dose for any one month during the pregnancy not exceed 50 millirem. GSFC includes this NCRP recommendation on the monthly limit as well as the stated regulatory limit for the gestation period.

It is the responsibility of the employee and her supervisor to observe the principles of radiation safety and use standard precautionary procedures in the performance of her duties to keep her radiation dose ALARA at all times and especially during the gestation period. The RPO shall provide training and assistance in maintaining doses ALARA.

Information concerning radiation exposure to the fetus/embryo can be found in "Questions & Answers Concerning Prenatal Radiation Exposure" and instruction for declaring a pregnancy (Pregnancy Declaration Letter) can be found on the GSFC Safety 1st Web site found at http://safety1st.gsfc.nasa.gov/index.php

9.5 Internal Exposure

9.5.1 Bioassay Program

Bioassay is the determination of the kind, quantity or concentration, and location of radioactive material in the human body by direct (in-vivo) measurement or by analysis (in-vitro) of materials excreted from the body. Commonly employed bioassay techniques include urinalysis and thyroid monitoring. Our bioassay program provides the necessary personnel monitoring to measure operational or accidental uptakes by radiation workers.

The RSO, during the review of applications, personnel monitoring needs and frequency, makes a determination of bioassay needs. The status of usage programs is periodically reviewed through radiation worker registrations, surveys, inventory records, and verification of radiation staff and radionuclide use limits.

Routine bioassay monitoring shall be conducted when any individual is working with radionuclide form/activity combinations exceeding established limits. "Working with" includes withdrawing an aliquot from a stock supply which itself exceeds a limit, even though the activity actually used is below the bioassay limit.

9.5.2 Notification Requirements

Tritium (H-3); Iodine (I-125, I-131). Before utilizing tritium or radioiodine, radiation workers shall contact the RPO so that a review can be conducted to see if baseline bioassays need to be established.

***Other Radionuclides*.** Urinalysis is required within 24 hours, if possible, but not later than 72 hours following potential ingestion, inhalation, or skin contamination of personnel. Baseline bioassays shall be conducted for anyone who may use 10 mCi or more of radioactivity in a gaseous or volatile form.

9.5.3 Analysis and Records Keeping

Standard methods for bioassay evaluations are normally sufficient to measure body or organ uptakes of radionuclides to a small fraction of a maximum permissible body burden. An outside laboratory specializing in bioassay services will be used for any analysis requiring extraordinary equipment or procedures. Bioassay results shall be recorded and maintained by the RPO as part of the radiation worker's overall personnel monitoring history.

9.6 Physical Examinations

The GSFC Medical Director, in accordance with NPR 1800.1, shall determine the frequency and type of examinations. Examinations are not required for personnel to receive approval to use ionizing radiation sources or devices.

10.0 CUSTODIAN RECORDS AND REQUIRED NOTIFICATIONS

Under the terms of the Center's authorizations to use radioactive materials, the RPO is charged with maintaining control of all radioactive materials on the center. In order to facilitate this oversight and to ensure that a high awareness of the rules and regulations governing the safe use of radioactive materials is maintained, it is required that certain records and reference materials be maintained by the Custodian. The Custodian is required to keep the records current and to make them readily available to laboratory workers and the RPO. A notebook shall be maintained with the required information. Records are to be maintained by the Custodian for a period of three (3) years unless advised otherwise.

Copies of the following shall be available in the laboratory:

a. radioactive material inventory records submitted to the RPO
b. radiation and contamination surveys performed by the Custodian
c. radioactive material transfer receipts and radiation source sign-out logs
d. radiation worker training certificates

Copies of the following shall be available from the Custodian:

a. authorization to use radioactive materials and attachments
b. radiation worker registration forms (GSFC Form 23-35IP)

The following incidents shall be reported immediately to the RPO (by calling 6-0280) and the Emergency Console (by calling 911):

a. contamination of personnel
b. the ingestion, inhalation, or any internal deposition of radionuclides
c. a lost or missing radioactive source (including waste)
d. radioactive spills involving 10 or more microcuries (μCi)
e. a laboratory accident (fire, explosion, etc.) which may have resulted in the release or breach of security of radioactive materials
f. any unusual conditions or violations detected during surveys or inspections (does NOT require a call to 911)
g. *NOTE*: The RPO will work with the Custodian to document the incident and the responsible manager and the Custodian shall provide for follow-up action to correct the situation (approved by the RSO) and will inform the RPO when corrective action is complete.

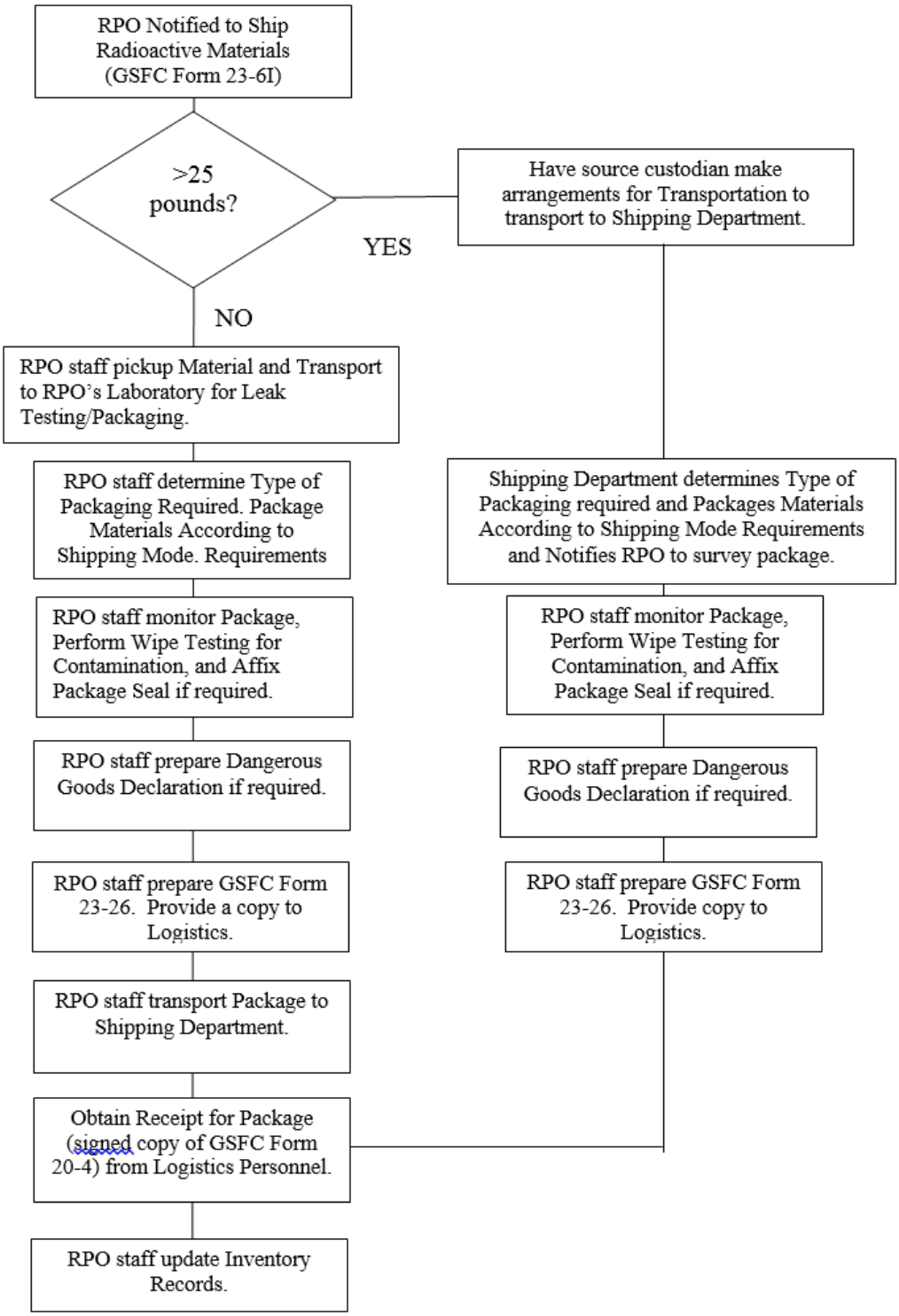
11.0 SHIPPING, RECEIVING OR TRANSFER OF RADIOACTIVE MATERIALS

All regulations (if applicable) for shipping of radioactive sources, established by the Department of Transportation (DOT), the International Atomic Energy Agency, the International Air Transport

Association, the Federal Aviation Administration, and the U.S. Coast Guard, shall be followed when shipping radioactive sources.

All shipments of radioactive material shall be coordinated through the RPO. Custodians will notify the RPO of any requirement for an incoming shipment, outgoing shipment, or transfer sufficiently in advance to make the necessary arrangements. The RPO will keep records of all shipments and transfers of radioactive materials involved in GSFC operations. For each shipment, this will include GSFC Form 23-26, GSFC Form 23-27, and a copy or reference to an applicable GSFC Form 20-4 (See Flow Diagram below).

Flow Diagram



11.1 On Campus Transfers

Any transfer of radioactive materials between buildings on Center shall be completed by the Radiation Protection Program Support Staff (RPO). The Custodian will contact the RPO of the need for a transfer and they will verify that the receiver is approved to use the radionuclides and that they are staying within their possession limits. The RPO will perform a leak test on each source being transferred, prior to the move, to ensure no presence of contamination. A GSFC Form 23-42: *Radioactive Material Onsite Transfer* will be completed for each transfer and will be signed by the receiver. A copy of this form will be given to the Custodian. See also Section **7.14 Transporting Radioactive Materials (On Campus)**

11.2 Off Campus Transfers

Any shipment of radioactive material off the Center shall be in full compliance with U.S. DOT and U.S. NRC regulations. Persons contemplating shipping radioactive materials will work with the Radiation Protection Program Support Staff to ensure compliance with the regulations. The RPO ensures that all packaging of radioactive materials is done in the proper manner.

Only those people specifically certified shall package radioactive material for shipment. Package radiation surveys, wipe tests and labeling are completed by the RPO.

11.3 Shipping Requirements

a. Shipments shall only be made to persons who are licensed to receive radioactive materials and in accordance with procedures established by such persons.
b. Prior to making a shipment of radioactive materials, a copy of the recipient's radioactive materials license shall be on file in the RPO.
c. All aspects of the shipment (container, packaging, labeling, surveys, shipping papers, etc.) shall be in accordance with U.S. DOT requirements.
d. Packaging and shipping of radioactive material shall be arranged through GSFC's Shipping Division.

11.4 International Shipments

For international shipment, RPO staff will coordinate shipping activities with GSFC Transportation at the earliest opportunity. International shipments will also require one of the following documents prior to shipment:

a. Written agreement of a company or organization licensed by the government of the foreign country to accept responsibility for the source(s) with a copy of the license.
b. Written authorization from a qualified government official of the foreign country authorizing import and use of the source(s).
c. Written authorization from the NASA Headquarters International Affairs Division for import and use of the sources(s) in the foreign country.
d. Written authorization from the U.S. Department of State for import and use of the source(s) in the foreign country.

11.5 Incoming Shipments

Incoming shipments of radioactive material shall be received and opened only by RPO staff or specifically approved persons as designated by the RSO. All incoming shipments will be leak tested prior to delivery to the Custodian. The Custodian will need to have an approved GSFC Form 23-6I on file for all ionizing radiation sources received prior to the source(s) being delivered to them.

12.0 ALARA PROGRAM

12.1 ALARA PROCEDURES

The primary objective of the Radiation Protection Program is to ensure that exposure to ionizing radiation for each individual Radiation Worker and Member of the Public is As Low As Reasonably Achievable (ALARA). The ALARA philosophy for radiation safety is to maintain minimal levels of occupational radiation exposures and releases of radioactive effluents to the environment. The IRSC, with the RSO as its delegated representative, will develop and implement procedures to ensure radiation exposures are ALARA. As a general principle of radiation safety and a specific policy of the Center, exposure to radiation shall be maintained at levels that are ALARA.

The following procedures are utilized to keep radiation exposures ALARA:

a. The IRSC shall review quarterly and annually radiation worker doses, investigating ALARA notifications (see 12.2) to determine whether exposures are being kept to a minimum.
b. The IRSC shall carefully review applications for radioactive material authorization, to ensure that the applicant is qualified and that the proposal incorporates ALARA procedures.
c. Investigation levels for occupational radiation exposures will be adopted by the IRSC. When these levels are exceeded, the RSO shall notify the recipient and review work practices, etc., in order to attempt to lower the exposure if possible.
d. The RSO shall provide training to radiation workers and ancillary personnel regarding the ALARA philosophy and methods to keep exposures ALARA.

12.2 ALARA Investigation Levels and Reporting

The IRSC reviews quarterly ALARA reports prepared by the RSO. Appropriate action will be taken on external and internal radiation doses that exceed the investigation levels listed in the Table 12.2. The RSO, based on any concerns noted during surveys/inspections conducted or review of radiation exposure reports, may require actions to be taken before these levels are exceed.

ALARA investigation levels and reporting frequencies different than those listed may be established by the RSO. Justification for the new action levels or reporting frequencies shall be documented and consistent with good ALARA practices. Prior approval of the justification by the IRSC is required for all revisions to the investigation levels.

There are two investigation levels for the ALARA program, Level I and Level II (See Table 12.2). Level I notifications normally involve a radiation worker receiving a dose greater than the values listed in Table 12.2. The recipient is notified in writing when their exposure meets these criteria. The

notification requests that the worker review their work procedures in order to reduce exposure, if feasible.

Level II notifications normally involve a radiation worker receiving greater than 10 percent of the maximum allowable dose. The recipient is notified when their exposure meets these criteria. In addition to reviewing procedures as with Level I, Level II requires the worker to respond in writing to the RPO. The response shall include the cause of the exposure and actions that may be taken to reduce the probability of a recurrence.

The IRSC may adopt different, higher ALARA levels for some specific job functions.

Table 12.2: ALARA Investigation Levels

Part of Body	**Level I**	**Level II**
	Quarterly (mrem)	
Whole body (head, trunk), gonads, upper arms or legs	40	125
Lens of the eye	125	375
Skin of whole body; extremities (hand, elbow, lower arms or legs, foot, knee)	400	1250
Embryo-fetus	N/A	12.5

13.0 EMERGENCY PROCEDURES

In any radiation emergency, personnel protection and emergency medical care have priority over radioactive decontamination of the building and equipment. For all cases, first call 911 (Emergency Console) or extension 1333 (for Wallops); during normal working hours call the RPO (phone #6-0280 or 6-8482); after hours, RPO shall be notified as soon as possible. However, the emergency may demand other immediate action by those on the scene before this can be done. It is impossible to draw up a set of specific rules and procedures that would cover each eventuality. Therefore, the following paragraphs present a set of general guidelines that all radiation workers should study, remember and implement as circumstances and common sense dictate.

It is further expected that radioactive material users will develop a safety-oriented culture that actively anticipates potential hazards and accidents with an eye towards prevention as well as a predisposition to appropriate response to the unexpected. The Custodian shall be prepared for minor spills and reasonably anticipated emergencies. He/she can prearrange to have on hand specific equipment and supplies uniquely required by her/his operation to minimize hazards and enhance recovery.

When radiation safety problems arise, the senior individual immediately responsible for the operation shall notify the RPO.

13.1 Radioactive Material Spills

For spills that involve radioactive material, the following steps shall be taken in the order listed.

a. Take care of personnel injury first; dial 911 if emergency assistance is needed.
b. Secure the area and ensure that personnel do not enter the area.
c. Notify the RPO for guidance (6-0280 or 6-8482)
d. Follow guidance provided by the RPO

13.1.1 Personnel Protection

a. If hazard is extreme (high radiation level or suspect air contamination), evacuate the area immediately; close and lock the door (to help contain airborne transfer).
b. Remove contaminated clothing and wash contaminated parts of the body thoroughly with warm water and mild soap.
c. Call 911 (for GSFC) or extension 1333 (for Wallops), then the RPO (6-0280 or 6-8482)
d. Warn fellow workers of the spill hazard and keep others out of the area.

13.1.2 Contamination Control

a. Localize and control area of spill. Place absorbent material over a liquid spill.
b. Do not track contamination out of the spill area, if possible. Remove shoes at the edge of contaminated area if they may be contaminated.
c. If contamination is widespread outside the laboratory, call 911 to get Security (code 240) to assist in securing the area.
d. Check all objects and clothing for contamination before leaving the area.

13.2 Serious Injury with Radiation Exposure or Contamination

If personnel have received high radiation exposure or radioactive contamination in addition to physical injury requiring immediate medical assistance, call Emergency Console (911) or extension 1333 (for Wallops), then the RPO (6-0280 or 6-8482). When emergency personnel arrive, inform them that the patient might be contaminated or exposed to radiation.

Someone familiar with the incident shall accompany the injured to the hospital to provide information, such as the nature of the injuries, radiation levels, the physical and chemical nature of the contamination, etc.

13.3 Fire or Explosion in a Radionuclide Area

In case of fire or explosion, call Emergency Console (911) or extension 1333 (for Wallops), then the RPO (6-0280 or 6-8482). If possible, stay on the scene to acquaint emergency personnel with the nature of the radiation hazards present and to assist them as required. Also, follow instructions for Major Radioactive Spills.

13.4 High Radiation Exposure without Contamination

In case of an overexposure, do what can be done to terminate or limit the exposure and to prevent others from being exposed. Call 911 (for GSFC) or extension 1333 (for Wallops), then the RPO (6-0280 or 6-8482). Assist in collecting data to estimate the nature and extent of the exposure.

13.5 Decontamination Procedures

Abortive attempts at decontamination can make things much worse. Unless immediate action is demanded to safeguard personnel, decontamination shall be done under the supervision of RPO staff.

Laboratory personnel are normally required to perform the major portion of the decontamination. RPO staff shall determine the procedures and equipment to be used and will render assistance as necessary.

All personnel and areas involved shall be monitored to assure adequate decontamination before normal work is resumed. Personnel will obtain clearance from RPO staff before leaving the immediate vicinity.

13.5.1 Limits for Skin Contamination

The RPO records removable contamination levels in terms of disintegrations per minute (dpm) per 100 square centimeters (standard areas to be covered by a "wipe"). Table 13.5.1 lists permissible limits for skin contamination. If these levels are thought to be exceeded, the RPO shall be notified.

Table 13.5.1: MAXIMUM PERMISSIBLE SKIN CONTAMINATION LEVELS

Location	Alpha (dpm/100 cm^2)	Beta-Gamma Measured at 1 cm		Transferable (Smear) Alpha/Beta/Gamma
		mrem/hr	microsieverts/hr	
Body	150	<0.06	<0.6	None Detectable
Hands	150	<0.10	<1.0	None Detectable

13.5.2 Surface Contamination Limits

Surface contamination limits for radiation control area are described in Table 1356.2. Surface contamination limits for unrestricted areas are limited to the levels identified as “general use area”. The following actions are to be taken as a function of contamination levels:

Table 13.5.2: SURFACE CONTAMINATION LEVELS AND REQUIRED ACTIONS

Research Laboratories (Radiation Use Areas)	Actions
<1000 dpm/100 cm^2 beta/gamma <100 dpm/100 cm^2 alpha	Cleanup to less than 200 dpm beta/gamma or 20 dpm alpha and as far below as practicable is required. Lab coat and gloves required. Personnel may leave the area and equipment may be removed only after RPO monitoring shows them to be clean. Radiation control area signs shall indicate that the area is contaminated and list requirements for entry.

Table 13.5.2: SURFACE CONTAMINATION LEVELS AND REQUIRED ACTIONS	
Research Laboratories (Radiation Use Areas)	**Actions**
≥1000 dpm/100 cm^2 beta/gamma ≥100 dpm/100 cm^2 alpha	Coveralls, gloves, and shoe covers are required. Personnel may leave area only after monitoring shows them to be clean. Equipment may be removed from area only after monitoring by RPO. Radiation control area signs shall indicate area is contaminated and list requirements for entry.
≥100,000 dpm/100 cm^2 beta/gamma ≥10,000 dpm/100 cm^2 alpha	Requires specific operating procedures (which includes clean-up requirements) approved by the IRSC.
General Use Areas	**Actions**
<200 dpm/100 cm^2 beta/gamma <20 dpm/100 cm^2 alpha	No actions required.
≥200 dpm/100 cm^2 beta/gamma ≥20 dpm/100 cm^2 alpha	Ensure the area is cleaned to less than 200 dpm/100 cm^2 beta/gamma and less than 20 dpm/100 cm^2 alpha.

13.6 Airborne Contamination Limits

The concentration of airborne radioactive material in an occupied radiation control area or an unrestricted area may not exceed the amount specified in 10 CFR 20, Appendix B, Table 1.

13.7 Radiation Event Reporting and Investigation

In addition to the GSFC's reporting requirements for mishaps, incidents, and close calls, all such events involving radioactive sources used under GSFC's NRC licenses shall be immediately reported to the RPO staff. The RPO staff will provide support to the user organization if a problem with source integrity is observed. The RSO will conduct an investigation and prepare a report to the IRSC regarding failure of any committee-certified sealed source.

Appendix A – Definitions

A.1 Airborne Radioactive Material – Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

A.2 Airborne Radioactivity Area – An area where airborne radioactive materials, composed wholly or partly of licensed material, exist in specific concentrations.

A.3 Ancillary Personnel – Any persons who have unrestricted access to areas where radioactive materials are stored and/or used, including any persons involved in maintenance and janitorial duties in radiation areas.

A.4 Annual limit on intake (ALI) - The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to an individual organ or tissue.

A.5 Approved User – Any employee or contractor who has been approved by the Ionizing Radiation Safety Committee (IRSC) to use specific sources of ionizing radiation or devices for specific purposes and at specific locations.

A.6 Becquerel (Bq) - The International System unit of radioactivity, equal to one nuclear decay or other nuclear transformation per second.

A.7 Bioassay- The determination of kinds, quantities or concentrations, and, some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

A.8 Curie (Ci) - A quantity of radioactivity. One Curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7E10 disintegrations per second (dps). Commonly used submultiples of the Curie are the millicurie and the microcurie. One millicurie (mCi) = 0.001 Ci = 3.7E07 dps. One microcurie (μCi) = 0.000001 Ci = 3.7E04 dps.

A.9 Custodian – An individual who has been designated by the appropriate management and approved by the IRSC to assume the responsibility of accountability for specific sources of ionizing radiation.

A.10 Device – Any piece of equipment that produces ionizing radiation.

A.11 Exposure – The state of having been exposed to ionizing radiation or to radioactive material.

A.12 Extremity – The hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

A.13 Gray (Gy) – The unit of absorbed dose. One gray is equal to an absorbed dose of 100 rads.

A.14 High radiation area - An area, accessible to individuals, in which radiation levels may result in an individual receiving a dose equivalent in excess of 100 mrem (1 mSv) in one hour at 30 centimeters from the radiation source or from a surface that the radiation penetrates.

A.15 Ionizing Radiation – Radiation that has sufficient energy to remove electrons from atoms.

A.16 Kilovolt Peak (kVp) - The maximum voltage applied across an X-ray medium, which determines the kinetic energy of the electrons accelerated and the peak energy of the X-ray spectrum.

A.17 Rad - The special unit of absorbed dose. One rad equals an absorbed dose of 0.01 joule per kilogram (0.01 gray) or 100 ergs per gram.

A.18 Radioactive Materials Area – An area or room in which radioactive material is used or stored in quantities specified in 10 CFR 20.1902(e).

A.19 Radiation area - An area, accessible to individuals, in which there exists radiation at levels that an individual may receive in excess of 5 millirems (0.05 mSv) in one hour at 30 centimeters from the radiation source or from a surface that the radiation penetrates.

A.20 Radiation Worker – Same as an Approved User

A.21 Rem - A special unit of quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (one rem = 0.01 Sievert).

A.22 Restricted area - An area access to which is limited by the licensee for purposes of protection of individuals against undue risks from exposure to radiation and radioactive materials.

A.23 Roentgen - The special unit of exposure. One roentgen (R) equals 2.58E-04 coulombs per kilogram of air (see "Exposure").

A.24 Sealed Source - Radioactive material that is permanently bonded or fixed in a capsule designed to prevent leakage or escape of the radioactive material.

A.25 Sievert (Sv) - The international system (SI) unit for dose equivalent equal to 1 Joule/kilogram. The Sievert has replaced the rem. One Sievert is equivalent to 100 rem.

A.26 Source – Any material that produces ionizing radiation. Sources can be licensed or unlicensed.

A.27 Source Record – All records associated with a given ionizing radiation source, including the records from the supplier and all subsequent records.

A.28 Tritiated - To replace normal hydrogen atoms, or chemically combine something, with tritium

A.29 Unrestricted Area – means an area, access to which is neither limited nor controlled by the licensee.

A.30 Unsealed Source – Radioactive material that is not encapsulated or otherwise contained. The implication is that unsealed radioactive material can move around and if uncontrolled would lead to contamination.

A.31 User Organization – The organization that is using a source or device, and is responsible for ensuring requirements are met.

Appendix B – Acronyms

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
DOT	Department of Transportation
dpm	disintegrations per minute
GPR	Goddard Procedural Requirements
GSFC	Goddard Space Flight Center
HEPA	High Efficiency Particulate Air
IRSC	Ionizing Radiation Safety Committee
kVp	Kilovolt Peak
NCRP	National Council on Radiation Protection and Measurements
NPR	NASA Procedural Requirements
NRC	Nuclear Regulatory Commission
PPE	Personnel Protective Equipment
RPO	Radiation Protection Office
IRSC	Ionizing Radiation Safety Committee
RSO	Radiation Safety Officer

APPENDIX C: At Sea/Field Use of Radioactive Material

C.1 AUTHORIZATION

For GSFC Research personnel, prior approval by the RSO and IRSC is required for all work involving the use of sealed sources and/or radioactive material on board research vessels or at field locations.

For Non-GSFC Research personnel who wish to conduct research under GSFC's Radioactive Material License, prior approval by the RSO and IRSC is required for all work involving the use of sealed sources and/or radioactive material on board research vessels or at GSFC owned or controlled locations.

A GSFC Form 23-6I, "Ionizing Radiation Source Use Approval" shall be completed and submitted a minimum of 60 days prior to the intended field use to allow adequate time for evaluation. The name of the ship or the field location (the State and geographical location), and the expected dates of use should be included in the request.

Requests should be submitted for each cruise or field use. It is the responsibility of the Researcher requesting the Approval to inform the GSFC RSO of the proposed use of isotopes or sources of ionizing radiation. This shall include the specific isotope, activity and physical form.

A summary of the research protocol(s) to be used shall be submitted with the request and should include a description of the laboratory techniques and procedures that will be used when working with the radioactive material, and decontamination procedures. If the material is also in a hazardous form (e.g., readily dispersible, volatile, etc.), a description of the controls that will be used to ensure safe operations will be indicated.

C.2 RADIOLOGICAL WORK AND SAFETY PRACTICES

All requirements from authorizations and this GPR shall be followed. The following practices are supplemental and should be followed as applicable.

a. The radiation protection requirements of the GPR to maintain occupational exposure to radiation As Low As Reasonably Achievable (ALARA) shall be applied to all operations.
b. The existence of this GPR and its storage location shall be known by all personnel approved to use radioactive material.
c. Gloves and a lab coat shall be the minimum protective clothing requirement when working in laboratory areas where dispersible radioactive materials are used. If hazardous chemicals are used, safety glasses and appropriate PPE for the chemical in use must be worn.
d. After handling radioactive materials, radiation workers shall conduct a personnel contamination survey of exposed skin, hair, and clothing prior to leaving the laboratory.
e. Any potentially radioactively contaminated equipment/materials shall be surveyed prior to removal from the radiological work area.
f. Dispose of radioactive waste only in approved and properly labeled containers.
g. Secure all licensed radioactive material when it is not in use.
h. Ensure all persons handling radioactive material are trained, approved, and listed on an approved GSFC Form 23-6I.

i. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal.
j. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the RSO. All radioactive material hoods shall be properly labeled.
k. Work at sea involving radioactive materials shall be limited to the isotope van, unless an alternate work location has been requested and approved.
l. Special considerations for the type(s) and quantity of waste generated by the research and the method of waste handling shall be planned in advance and approved by the RSO.
m. Disposal at sea is not permitted and facilities for storage of waste onboard the research vessels are very limited.

The names of all individuals who will handle radioactive material, along with a summary of their training and experience in the safe use of radioactive material should also be included on the GSFC Form 23-6I. Applications from individuals from an Institution other than GSFC shall include documentation from that Institution's RSO that indicates the individual has received Radiation Safety Training and that they are approved to use the particular radionuclides in the amounts requested.

Approved Researcher(s) shall provide their own consumable supplies, including protective clothing, gloves, workbench absorbent blotters, secondary containment, etc. The research vessels do not carry these supplies or emergency materials, such as absorbent spill pillows or decontamination materials.

C.3 CONTAMINATION CONTROL

Control of contamination aboard the research vessels and at field sites is of vital importance.

a. Contamination surveys shall be conducted in all areas where radionuclides are used or stored.
b. It shall be the responsibility of the Researcher requesting Authorization to ensure that required contamination surveys are conducted, as specified in the GSFC Form 23-6I approval.
c. When onboard a Research Vessel, the isotope van shall be equipped with a simple liquid scintillation counter that can be used for obtaining immediate results. Counting supplies will be provided by the researcher. The researcher will insure that counting equipment is available on-board ship.
d. Any radioactive contamination detected by wipe tests requires immediate decontamination by the user.
e. Any major spills or accidents involving radionuclides shall be reported immediately to the Custodian, the Ship's Captain or designated licensed officer, and the GSFC RSO (work phone: 301-286-0280). Upon completion of the cruise or fieldwork, the Custodian will submit a detailed report within 30 days of the incident to the GSFC RSO that includes the corrective measures taken.

C.4 MONITORING EXPOSURE TO IONIZING RADIATION

When required by the GSFC RSO and the use authorization (GSFC Form 23-6I); Researchers and Staff shall wear monitoring devices provided to them as part of the GSFC Radiation Exposure Monitoring Program. Individuals from other Institutions, who have been granted Authorization for use of

radioactive materials and/or sources of ionizing radiation under GSFC's license, are responsible for providing and maintaining their own radiation dosimetry through their parent Institution. Individuals from other Institutions that are working under a GSFC researcher's Authorization shall be provided dosimetry as applicable with the GSFC dosimetry program.

C.5 WASTE DISPOSAL

Specific arrangements shall be made before the cruise or fieldwork for the storage and ultimate disposal of radioactive and hazardous waste. GSFC's NRC License specifically forbids disposal of radioactive materials into the sea or at field locations.

It is the responsibility of the Custodian to arrange for the removal and disposal of the low-level radioactive waste they have generated. This situation requires prior arrangement and approval by the GSFC RSO. The cost for this disposal is still the responsibility of the Custodian or project manager.

Special efforts shall be made to keep the volume of waste as low as possible. In addition, while working in a research environment, hazardous chemicals are, at times, used together with the radioactive material. The combination of radioactive and hazardous waste results in the formation of mixed waste. Mixed waste requires special care resulting in larger disposal costs and should be avoided whenever possible.

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	06/02/03	Initial Release
A	01/27/05	Changes made to clarify all requirements in accordance with NASA Rules Review Committee recommendations. Modified to show change from responsible Branch to Division.
B	09/29/08	Complete revision to the GPR was completed and the title of the GPR was changed.
C	11/10/10	Administratively revised to correct organization name and code change.
D	01/05/17	Major revisions to the document were made to bring it current with current organization structure and procedures.